

Systematic Review and Meta-Analysis: The effect of dance movement on cognitive function in the elderly in various countries

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ABSTRACT

Cognitive decline in the elderly is a growing global concern, with significant individual and healthcare impacts. This systematic review evaluates the effects of dance movement interventions on cognitive function in older adults across diverse populations. Following PRISMA guidelines, databases including Google Scholar, PubMed, and ScienceDirect were searched, and 27 studies met inclusion criteria. Data from 934 participants were analyzed using RevMan 5.1, applying a random-effects model to calculate standardized mean difference (SMD) and 95% confidence intervals (CI). Results showed a significant positive effect of dance interventions on cognition (SMD = 0.48, 95% CI [0.14, 0.82], $P = 0.005$), though heterogeneity was high ($I^2 = 92%$). Beyond cognitive improvements, benefits included enhanced motor skills, physical function, reduced depressive symptoms, and greater psychological well-being. Moreover, these interventions have a notable positive impact on overall psychological well-being.

KEYWORDS: cognitive function; dance movement; elderly; mental health; geriatric

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INTRODUCTION

Cognitive decline is one of the significant issues faced by the elderly population in various countries. With the increase in life expectancy, the prevalence of cognitive disorders and dementia also rises, placing a significant burden on healthcare systems and families. According to the World Health Organization (WHO) in 2021, the prevalence of cognitive disorders worldwide continues to increase as the elderly population grows, with over 55 million people globally suffering from dementia. This number is expected to double by 2050 (WHO, 2021).

Treatment of cognitive disorders such as dementia faces several complex issues. One of the main challenges is the lack of effective treatments to stop or slow down the progression of the disease. While some medications, such as cholinesterase inhibitors, can help manage early-stage symptoms, they cannot stop disease progression (Atri, 2019). Additionally, existing treatments often focus only on symptoms without addressing the underlying causes, such as neurochemical changes and brain structure alterations that occur in Alzheimer's disease (Dufour & Roy, 2020). Moreover, care for cognitive disorders often involves multidimensional management that requires an integrated approach, including non-pharmacological therapies like cognitive training and physical activity, which can improve quality of life but are not widely available (Zhang et al. 2019). Limited access to appropriate treatments and a lack of awareness about the importance of early detection further exacerbate this issue, especially in resource-limited countries (Gauthier et al. 2016).

In this context, interventions that can slow cognitive decline or even improve cognitive function become crucial. One approach that has gained significant attention in recent years is dance movement, which is believed to provide cognitive benefits for the elderly. Various studies have shown that physical activities like dancing can stimulate brain functions and help improve cognitive health. For example, a study in the United States found that participation in a dance program was significantly associated with improvements in memory and thinking skills in older adults (Keogh & Kilding, 2017). Studies in Europe also support this finding, highlighting that dance activities can stimulate various brain functions, such as memory, attention, and spatial abilities (Müller et al. 2020). In Asia, research on older adults who participated in traditional dance programs showed improvements in cognitive aspects related to concentration and problem-solving (Kattenstroth et al. 2013).

Dance is not only a physical activity but also involves social and emotional components that can enhance mental well-being and enrich sensory experiences (Zhang & Hu, 2021). Older adults engaged in such activities also experience a reduction in symptoms of depression and anxiety, which indirectly contributes to the improvement of cognitive function (Zhang & Wu, 2019).

Furthermore, elements such as memory of steps, body coordination, and attention required in dance provide multisensory stimulation beneficial to the brain (Burge et al. 2017).

This systematic review is conducted to explore the impact of dance on the cognitive function of the elderly across various countries. It aims to evaluate the effectiveness of dance movement in improving cognitive function in the elderly across different cultural and population backgrounds and to identify the underlying mechanisms responsible for such improvements

METHODS

Article Search Strategy

This systematic review and meta-analysis adhered to the guidelines established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), ensuring a rigorous and transparent approach to study selection and data analysis. The full PRISMA guidelines are accessible at (www.prisma-statement.org). The research process was structured through several critical stages: comprehensive and systematic searching of relevant articles, meticulous screening and review of each article, data abstraction and quality assessment, synthesis of findings, and detailed reporting of results (Alimoradi et al. 2019). A comprehensive literature search was conducted across three major databases: Google Scholar, PubMed, and ScienceDirect. The search was guided by a set of carefully chosen keywords, including 'cognitive function', 'dance movement', 'geriatric care', 'physical activity', and 'intervention studies'. Articles were screened and selected based on clearly defined inclusion and exclusion criteria to ensure relevance and quality.

Inclusion and Exclusion Criteria

The inclusion criteria for this review were: (1) studies involving elderly participants aged 60 years and above, (2) studies examining the effect of dance movement as an intervention, (3) studies measuring cognitive function outcomes, including memory, attention, or cognitive processing, (4) original research articles such as experimental studies, randomized controlled trials, or intervention studies, (5) articles published in English, (6) studies published within the last ten years (from 2014 onwards), and (7) studies conducted in various countries to explore cross-cultural variations. The exclusion criteria were: (1) studies involving participants younger than 60 years or populations not specifically elderly, (2) studies that did not use dance movement as a primary intervention or combined dance movement with other interventions without isolating its effects, (3) studies not measuring cognitive function outcomes, (4) review articles, meta-analyses, commentaries, opinions, case studies, or brief reports, (5) articles published in languages other than English, and (6) studies without full-text access or only available as abstracts.

Registration Systematic Review

The protocol for conducting this systematic review has been registered in The PROSPERO with ID number (CRD42024609142). The webpage can be accessed at (<https://www.crd.york.ac.uk/prospero/>).

Quality assessment

The CONSORT checklist, a recognized tool comprising 25 items designed for reporting and evaluating various sections of interventional studies, was utilized to assess the quality of the current research.

Data Extraction

After reviewing and excluding studies that assessed the same population, data extraction included the following: Population (Elderly individuals aged 60 years and above); Intervention (Dance movement or dance-based activities); Comparison (No intervention, standard care, or other physical activities that are not dance-based); Outcome (Cognitive function outcomes, such as memory, attention, or executive function); Study Design (Randomized controlled trials (RCTs), non-randomized intervention studies, or quasi-experimental designs).

Statistical analysis and heterogeneity detection

The Rev Dev 5.1 software was utilized for the analysis, and a forest plot was employed to display the analysis results. The I² and Q tests were used to analyze literature heterogeneity, and I²>50% or P<0.05 was used to indicate statistical difference in heterogeneity.

RESULTS

The procedure for conducting the literature search is illustrated in Figure 1. The titles and abstracts of the preliminary search results were assessed. Following a thorough examination of the complete texts of potentially suitable articles, 28 papers that fulfilled the inclusion criteria and complied with all seven elements of the CONSORT checklist (indicating high quality) were included in the analysis. The selected studies were conducted in a variety of geographical locations, reflecting research carried out in multiple countries, including China (5); Australia (4); Brazil (4); France (3); Japan (3); United States (3); Canada (1); Croatia (1); Germany (1); Italy (1); Poland (1); South Korea (1); Spain (1); Sweden (1); Tunisia (1). The studies were evaluated for quality using the CONSORT checklist, with average CONSORT scores ranging from 16 to 25.

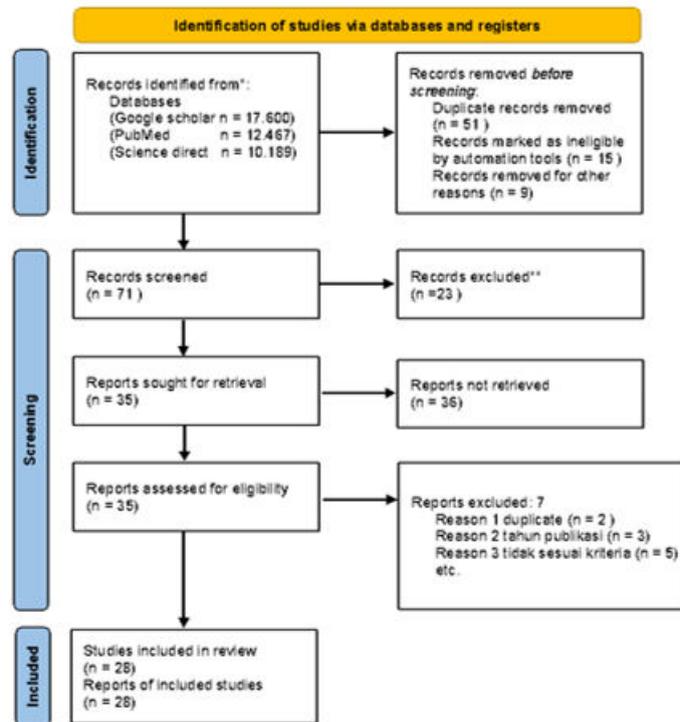


Fig. 1. PRISMA diagram for searching articles

Analysis of publication bias

Funnel plots were created to assess the effect of dance movement on cognitive abilities as the primary outcome measure. The analysis of these plots revealed a symmetric distribution of the literature on both the left and right sides, suggesting the presence of a small potential publication bias (Figure 2).

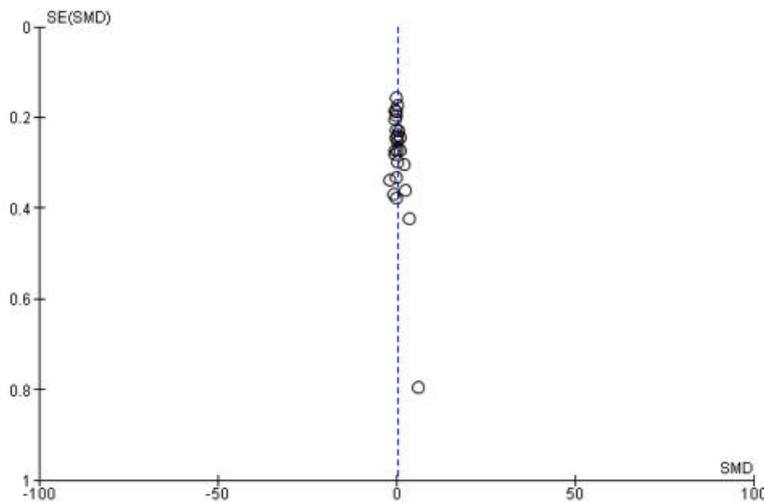


Fig. 2. Funnel plot for effect dance movement, Standard error (SE), Odds ratio (OR)

Meta Analysis

The meta-analysis results from 27 studies involving a total of 934 participants in the intervention group and the control group show that dance movement intervention has a significant impact on improving the measured outcome variables (e.g., psychological well-being, mental health, or cognitive capacity). The analysis using a random-effects model revealed a Standardized Mean Difference (SMD) of 0.48 with a 95% Confidence Interval (CI) of 0.14 to 0.82, and a p-value of 0.005 (Figure 3).

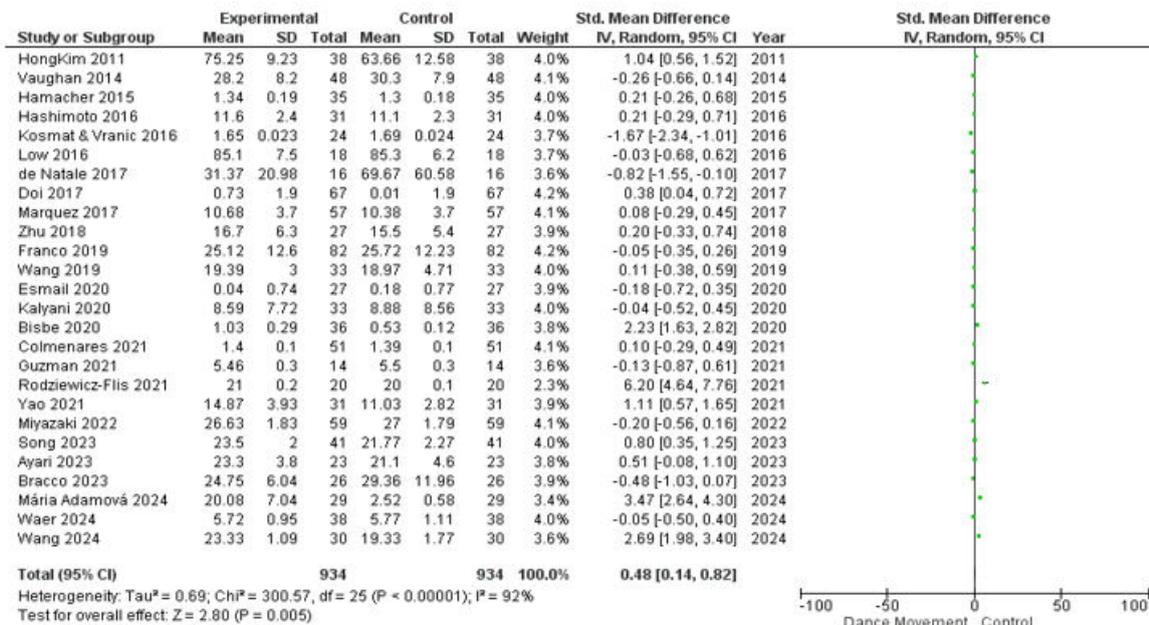


Fig. 3. Meta-Analysis of effect dance movement on cognitive abilities

DISCUSSION

In the meta-analysis results showed a SMD value of 0.48 of 0.48 with a 95% CI of 0.14 to 0.82, and a P-value of 0.005. These results indicate that dance movement has a moderate, statistically significant effect compared to the control group. However, the heterogeneity between studies is relatively high, with an I² value of 92%, suggesting substantial variability across the studies analyzed. Some studies showed very high effects, such as Mária Adamová (2024) and Wang (2024), which may contribute to the high heterogeneity. Therefore, sensitivity analysis or subgroup analysis is needed to better understand the sources of this high variability. These findings are consistent with previous research that states that movement-based interventions, such as dance movement therapy, have the potential to improve emotional well-being and cognitive function, as well as reduce symptoms of depression and anxiety (Bräuninger, 2012; Koch et al. 2014). Dance activity impacts not only the physical aspect but also the psychosocial and neurological aspects. This activity can enhance self-expression, social connection, and positive body perception (Narayana et al. 2023).

Nevertheless, the high heterogeneity in these findings is an important point to note. Variations in study design, intervention duration, participant age, and outcome measurement tools are likely contributors to the differences in results across studies (Bräuninger, 2012). Therefore, further studies with more consistent experimental designs and moderator analysis through meta-regression are essential to identify factors that may strengthen or weaken the effects of this intervention.

Cognitive impairment is a mental disorder characterized by compromised cognitive abilities, with causes that may be known or unknown. Cognitive impairment involves disruptions in thinking or memory, which reflect significant changes from an individual's usual level of functioning. Unlike psychological disorders, cognitive impairment arises from physical or mental conditions that affect brain function, commonly observed in older adults (Haeger et al. 2019). The typical pathophysiology of cognitive impairment includes damage to neural tissue, such as the cortex, thalamus, basal ganglia, and white matter. This damage often results from neurodegenerative processes like Alzheimer's, Parkinson's, multiple sclerosis, or Huntington's disease through immunological interactions with abnormal proteins. Mild cognitive impairment (MCI) is a transitional stage between normal age-related cognitive changes and early dementia. MCI has gained attention as an essential stage for intervention to prevent dementia. Psychiatric symptoms such as depression, anxiety, and apathy are frequently observed in patients with MCI (Haeger et al. 2019; Martin & Velayudhan, 2020).

The first effect of dance on cognition is episodic memory, a component of long-term memory that includes details of time, place, and emotions related to specific events, measured through various methods (Gethi & Bunge, 2012). In a study by Bisbe et al. (2020) on 31 patients with mild cognitive impairment (MCI) (17 in the dance therapy group and 14 in the physical therapy group), after 12 weeks of dance therapy, clinical assessment results differed significantly, measured using the Wechsler Memory Scale-Third Edition (WMS-III). The findings showed significant improvement in verbal recognition memory (mean diff. 95% CI: 1.03 [0.15, 1.91]; P=0.003**). The WMS-III is a neuropsychological assessment tool that evaluates various aspects of memory function. Further assessment using the Visual Memory subtest of the RBANS (Repeatable Battery for the Assessment of Neuropsychological Status), a brief test assessing visuospatial/constructional abilities, language, attention, short-term memory, and long-term memory, yielded a mean difference of 95% CI: 2.29 [0.38, 4.21]; P=0.022* (Ghetti & Bunge, 2012). A study by Marquez et al. (2017) on 55 older adults diagnosed with MCI, aged >55, showed that 12 months of aerobic dance had a significant effect on episodic memory, with a notable interaction between group and time (F(1, 55) = 5.78, p < 0.05), assessed by WMS and in patients with Parkinson's disease, 10 weeks of dance therapy improved cognitive function, measured by Trail Making Test A & B (TMT A, P=0.014; TMT B, P=0.036) (Azkona et al. 2009). Vaughan et al. (2014) used a similar method, finding

improvements in TMT A ($P=6.3$) and TMT B ($P=20.3$) after 16 weeks of dance therapy in older adults diagnosed with age-related cognitive decline (ARCD). These tests are common neuropsychological assessments for executive function, cognitive flexibility, processing speed, and visual-motor skills (Loughran et al. 2013). A study by Hamacher et al. (2015) on 35 patients with MCI aged >60 , divided into a dancing group and a health exercise group, found significant differences in motor-cognitive dual-task performance (group \times time: $F_{1,33} = 6.338$, $p = .018$; $\eta^2 = .196$). Public square dancing among 32 patients with MCI, aged 60–85, improved cognitive function, measured with the Subjective Exercise Experience Scale (SEES), showing increased psychological well-being from an average score of 11.03 ± 2.82 to 14.87 ± 3.93 ($P < 0.001$), indicating positive feelings from the intervention. Song et al. (2023) studied the effects of aerobic dance on 89 older adults aged >60 over 16 weeks, using the Montreal Cognitive Assessment (MoCA), with significant improvement in cognitive function ($P=.008$). MoCA scores improved to 26.80 in older adults after 4 weeks of dance [36]. MoCA was also used by Wang et al. (2024) and Zhu et al. (2018) to assess cognitive changes from dance interventions in older adults with MCI, with significant values of 23.33 and 25.0, respectively, compared to control groups. MoCA is a cognitive assessment tool designed to detect MCI across populations (Imaoka et al. 2022). Zumba dance therapy for 36 older adults aged >60 over 12 weeks was assessed for attentional capacities and visuospatial working memory. Another tool, the Severe Impairment Battery (SIB), was used by Low et al. (2016) to evaluate 18 dementia patients who underwent dance therapy, yielding a SIB score range of 75-95, with an average of 85.3 (SD 6.2), indicating improvements in cognitive function. Cognitive memory improvement was observed in older adults with MCI aged >70 after 40 weeks of dance therapy, with Mini-Mental State Examination and nonmemory domain scores of mean SD dance group 0.73 (1.9) versus control group 0.01 (1.9). Lastly, Colmenares et al. (2021) used T1w/T2w MRI to assess brain tissue changes, finding positive correlations with episodic memory improvement in adults aged >60 after six months of dance therapy.

A significant relationship exists between postural control and cognitive function. Postural control involves various sensory and motor systems that require effective coordination, particularly through the interaction of vestibular, visual, and proprioceptive systems. Declines in postural control are often closely linked to cognitive decline, as observed in individuals with mild cognitive impairment (MCI) or Alzheimer's disease (Imaoka et al. 2022; Redlicka & Zielińska-Nowak, 2021).

Rodziewicz-Flis et al. (2022) examined the effects of a 12-week dance intervention on postural control among 37 older adults over 60 years, with 20 participants receiving dance treatment and the remainder as controls. Outcomes measured included the Timed Up and Go (TUG) test, which assesses fall risk, functional balance, and mobility, and the 6-Minute Walk Test (6MWT), which measures functional capacity and integration of respiratory, cardiovascular, and locomotor systems, represented by total distance walked. Results showed positive effects on functional balance and mobility among the 37 participants. In the 6MWT, the control group exhibited a significant change in distance (371 ± 10.7 and 422 ± 11.4 m; $p = 0.0001$). The TUG test indicated a significant improvement in the Dance Group compared to the control group ($p = 0.018$). Using a similar TUG method, a tango dance intervention yielded significant results in older patients ($p = 0.039$). Waer et al. (2024) found similar outcomes, showing that Zumba dance improved postural control in older adults after 12 months of treatment, measured with a static stabilometric platform ($R^2 = 0.47$; $F=5.05$; $p < .05$) compared to the control group. Another study by da Silva Borges et al. (2018) applied postural measurement on 60 older adults receiving dance treatment, finding significant results compared to the control group, with dance effects of $X = 3.16 \pm 3.44$ ($p = 0.02$) versus control $X = 6.30 \pm 7.62$ ($p = 0.04$). Physical effects of dance on older adults were also observed by Esmail et al. (2020) in a study of 41 participants with an average age of 67.5 ± 5.37 years who underwent a 12-week dance intervention. The results showed significant improvements in 10-meter walking speed ($F(1,38) = 11.67$, $P=.002$, $n_2p = 0.24$), Timed Up and Go ($F(1,38) = 22.07$, $p < .001$, $n_2P = 0.37$), and Rockport time of completion ($F(1,37)=23.41$, $p < .001$, $n_2P=0.39$). Similarly, a 12-week senior dance intervention involving 82 MCI-diagnosed older adults improved balance and mobility with results in the standing balance test ($MD = 3.7$ seconds, 95% CI: 0.6 to 6.8), sit-to-stand test ($MD = -3.1$ seconds, 95% CI: -4.8 to -1.4), and 4-meter walk test ($MD = -0.6$ seconds, 95% CI: -1.0 to -0.1 [31]). Kim et al. (2011) also observed positive impacts in a study of 38 older adults with metabolic syndrome, showing improved scores on the CERAD-K (6.8), indicating enhanced verbal fluency, memory recall, and recognition function after a 6-month intervention. The study highlights cardiovascular risk factors (diabetes, hyperlipidemia, hypertension) as metabolic syndrome components associated with dementia risk. Physical activity is proposed to enhance cognition through cellular and molecular changes, structural and functional adaptations in the brain, and behavioral and socio-emotional modifications (Srillman et al. 2016).

Depressive symptoms in older adults can impact various cognitive functions, including memory, attention, information processing speed, and executive function (Wu et al. 2021; Hammar et al. 2022). Common assessments used to evaluate mental health, motor function, and quality of life, especially in patients with neurological conditions such as Parkinson's disease, include the Hospital Anxiety and Depression Scale (HADS), MDS-UPDRS-I, and QoL measures like PDQ-39 and MDS-UPDRS-II. Kalyani et al. (2019) used these methods to examine the effects of interventions on depressive symptoms in older adults with MCI, showing significant reductions in depression scores (HADS-Anxiety & Depression: $p = 0.035$ & $p = 0.001$; MDS-UPDRS: $p = 0.001$, and PDQ-39: $p = 0.001$). In a study by Hashimoto et al. (2019) on older adults over 60 years diagnosed with Parkinson's disease, a dance treatment significantly reduced depressive symptoms, measured by the Apathy Scale (10.2 ± 4.7) and the Self-rating Depression Scale (39.7 ± 7.0). Additionally, a 16-week aerobic exercise intervention for older adults with neuropsychiatric diagnoses demonstrated positive effects in reducing depressive symptoms, as assessed by the Geriatric Depression Scale-15 (GDS-15) (4.1 ± 2.9) and the Neuro-Psychiatric Inventory-R (NPI-R) (3.4 ± 1.4) (Franco et al. 2019).

The mechanism by which dance benefits cognitive function is multifaceted. It involves motor and sensory system activation that may decline as cognitive function decreases, often due to reduced neural structure activation and resource limitations. Dance routines, particularly in older adults, involve organized, relatively lengthy choreography, which enhances cognitive function, especially memory (Kimura & Hozumi, 2012). The positive effects of dance on cognitive decline, particularly for elderly individuals with MCI or Parkinson's, can be linked to a blend of physical activity, rhythm, and social interaction that stimulates

brain regions associated with memory, attention, and executive function.^{35,37} Dance therapy combines physical exercise with cognitive and social engagement, offering a comprehensive intervention. Research by Vaughan et al. (2014) suggests that dance boosts neurocognitive performance and raises brain-derived neurotrophic factor (BDNF) levels, a protein crucial to brain plasticity. Additionally, its accessibility and enjoyment make dance a sustainable activity for older adults across various cultural backgrounds. Studies such as Padilla et al. (2014) reveal that aerobic exercise can bring about physiological changes in the brain, including increased neurogenesis and the release of IGF-1. Both of these factors enhance learning and memory through the release of neurotrophic factors like BDNF and insulin-like growth factor-1 (IGF-1). This results in increased volume in the temporal lobe and prefrontal cortex. As aging progresses, there is a decline in serotonin transmission in the brain, often contributing to depression and cognitive impairment. Physical exercise has been shown to lower circulating serotonin levels like selective serotonin reuptake inhibitors (SSRIs), which may enhance cognitive ability (Zimmer et al. 2016). Studies by Rodziewicz-Flis et al. (2022) and Pietta-Dias et al. (2019) observed a significant decrease in serum serotonin levels among older women following dance interventions, mirroring SSRIs' effects by reducing blood serotonin concentrations, thus positively impacting depressive symptoms and cognitive function. Physical activity, including dance, also appears to protect against cognitive decline and dementia by influencing hippocampal volume and neuronal synapse formation. These processes accelerate gene expression for molecules involved in learning and memory.

CONCLUSION

The findings from this systematic review indicate that dance movements can stimulate brain function and improve memory, attention, depressive symptoms, and spatial abilities, contributing to overall cognitive health.

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